REMARKS

Applicants respectfully request further examination and reconsideration in view of the above amendments and arguments set forth fully below. Claims 1-14 and 18-25 were previously pending in this instant application. Within the Office Action, Claims 1-14 and 18-25 have been rejected. Accordingly, Claims 1-14 and 18-25 are now pending in this application.

Objections To The Claims

Within the Office Action, Claim 1 has been objected to because of certain informalities. Specifically, it is stated that a semicolon should be placed after the term "precursor" at the end of line 10. The Applicants respectfully submit that after careful analysis of the prior amendment, there is a semicolon remaining after the term "precursor" in Claim 1. The semicolon remains after the text that was deleted. Accordingly, no amendment has been made to Claim 1 and this objection should be withdrawn.

Rejections Under 35 U.S.C. § 103(a)

Within the Office Action, Claims 1-14 and 18-24 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over the Japanese Publication No. 05-097583-A to Shinya (hereafter "Shinya"), in view of U.S. Patent No. 5,236,545 to Pryor (hereafter "Pryor ") and either U.S. Patent No. 5,451,260 to Versteeg et al. (hereafter "Versteeg") or U.S. Patent No. 5,874,014 to Robson et al. (hereafter "Robson"). The Applicant respectfully disagrees with these rejections for the following reasons.

Diamond growth is a function of plasma density, reaction chamber pressure, carbon-to-oxygen ratio at the substrate surface, and precursor flow rate. The present invention provides a system for controlling all of these variables to promote rapid, substantially uniform and reproducible diamond growth. In accordance with the embodiments of the invention, the liquid precursor is continually supplied during the process without interruption. A dopant can be readily added to the liquid precursor, thus incorporating the dopant into the diamond structure formed. The method of the present invention allows diamond crystallites to be grown without seeding, provides a significant cost reduction over prior art methods and eliminates the need to use explosive gas mixtures or toxic precursors. As described below, there are several claimed

features which provide the aforementioned advantages, which are neither taught nor suggested in the prior art.

The present invention is directed to a method of synthesizing diamond utilizing plasma-enhanced chemical vapor deposition (CVD) using a "non-magnetic-field microwave plasma system." The present invention uses liquid precursors that are substantially free of water and that are formed from a mixture of methanol and at least one carbon and oxygen containing compound, such as ethanol, isopropanol, acetone or a mixture thereof. The carbon and oxygen containing compound has a carbon to oxygen ratio that is greater than one. The diamond growth process of the present invention is preferably carried out at relatively high pressures, such as in a range of 70 to 130 or 10 to 130 Torr. These and other distinguishing features are recited in each of the independent Claims 1 and 10.

Shinya discloses eliminating the need for hydrogen, due to its highly explosive nature, for the purpose of increasing safety in the plasma-enhanced chemical vapor deposition (CVD) of diamond. Instead of using hydrogen, Shinya incorporates an OH group-containing alcohol as the reaction gas. This reaction gas is used as feedstock to synthesize a diamond film without further diluting the gas with hydrogen. Of all the references cited, Shinya is most similar to certain aspects of the present invention. However, Shinya fails to disclose several features of the present invention. The first of these is the addition of at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one to the precursor composition. Pryor is cited within the Office Action in combination with Shinya to attempt to render this feature of the present invention as obvious. Additionally, Shinya fails to teach or suggest a liquid precursor that is in liquid form upon introduction into the reaction chamber and subsequently vaporized. The Office Action cites either Versteeg or Robson in combination with Shinya to render this second feature of the present invention as obvious. Shinya also does not disclose the pressure range of about 70 to 130 Torr.

Applicants respectfully submit that there is no expectation for success concerning the combination of Shinya with Pryor. Previously, Applicants have argued that all of Pryor's solutions contain hydrogen, the very reactive gas that Shinya's invention is aimed at eliminating. It is stated within the Office Action that "there is a reasonable expectation of success that the precursor mixtures of Pryor will achieve the result in Shinya without hydrogen, as Shinya teaches that one may eliminate hydrogen from the reaction mixture by using alcohols as a reactant gas."

Applicants respectfully submit that success in using Pryor's compositions for feedstock with Shinya's invention is unlikely to occur for several reasons. The first of these is the fact that all of Pryor's compositions contain hydrogen, the very gas which Shinya is aimed at eliminating. Furthermore, Shinya does not just avoid the use of hydrogen - it is a primary goal of Shinya. The Abstract of Shinya's application begins with the purpose of eliminating the need for hydrogen. If Pryor's compositions were removed from his invention and placed in Shinya's, this new combination would not work, as a diamond deposition process geared to operate in the absence of hydrogen would not operate successfully if the explosive gas were present. Pryor's compositions will not work in Shinya's diamond deposition method and therefore the two references would not have been combined by a person having ordinary skill in the art at the time of the invention, there being no expectation of success.

It is argued within the Office Action that "in light of the teachings of Shinya, it would be obvious to a person having ordinary skill in the art to remove the hydrogen from Pryor's composition and arrive at a successful composition for use in the deposition of diamond that is substantially similar to that used in the present invention." This argument fails to show either that there existed a reason to perform the chemical modifications necessary to achieve the claimed invention or that the combination would achieve success. Besides, Pryor's compositions do not merely contain hydrogen, but Pryor teaches that "it is preferred that the feedstock gas mixture comprise from about 90 to 99 volume percent hydrogen." [Pryor col. 9, lines 23-24] This overabundance of hydrogen would provide for a huge void in the composition if it were to be removed. The discrepancies between a composition of 100% alcohols (Shinya) and a composition of 99% hydrogen (Pryor) are too great to assume that the other 1% of Pryor's composition can be applied successfully to Shinya's entire precursor. Applicant's respectfully submit that to take the composition of Pryor and implement it into Shinya's method would involve the removal of 90-99 percent of the original composition. Replacing such a void and determining which composition of alcohols or other substances to use for such a replacement would not be obvious to a person having ordinary skill in the art.

Finally, the nature of Pryor's invention renders his use of carbon-containing precursors such as methanol or ethanol to be in a completely different environment than that of Shinya's. Shinya's invention deposits diamond films on a substrate in a reaction chamber. Pryor implements not only a substrate - limited to being comprised of silicon - within a reaction

chamber, but also requires the deposition of two additional layers as well. These two layers comprise an epitaxial cubic boron nitride layer and an ultra-thin, laser ablated diamond precursor carbon layer. Pryor explains the role of the layers when he states "the first interfacial layer provides a lattice-matching layer between the diamond and silicon layers...the second interfacial layer appears to prevent the volatilization of the cubric boron nitride layer in the presence of methyl radicals or other reactive species formed during the CVD process." [Pryor col. 3, lines 44-61] Furthermore, Pryor's deposition method requires "a combination of laser ablation and microwave CVD techniques." [Pryor, col. 3, lines 37-38] All of these factors establish the methods and conditions through which Shinya and Pryor accomplish the deposition of diamond to be substantially different. It follows that there is no expectation of success concerning the interchangeability and substitution of certain aspects of Pryor's precursor composition with Shinya's precursor composition.

Thus, despite the fact that Pryor uses carbon-containing precursors such as methanol or ethanol and combinations thereof, these alcohols constitute a minimal percentage of the precursor composition when compared to the presence of hydrogen. They are also implemented in substantially different conditions and through substantially different methods than the deposition process occurring in Shinya's process.

Applicants respectfully submit that by the above arguments, no expectation for success exists regarding the combination of Shinya with Pryor. Thus, no reference or combination of references cited teaches or fairly suggests a feedstock "containing methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one."

Even if a combination of Shinya with Versteeg or Robson taught the feedstock entering the chamber as liquid and then being vaporized, such a combination of references fails to render the claims of the present invention as obvious.

As described in a previous communication, Shinya fails to teach or suggest the use of a liquid precursor that is a liquid at the time that is introduced into the reaction chamber through the metering valve and vaporizes upon entry into the reaction chamber. Each of the independent Claims 1 and 10 specifies "wherein the liquid precursor enters the metering valve as liquid and vaporizes during entry into the reaction chamber" to further emphasize this distinguishing feature. The Applicant also respectfully points out that Shinya fails to teach or suggest the use of

a liquid precursor that is formed from a mixture of methanol and at least one carbon and oxygen containing compound, such as recited in each of the independent Claims 1 and an 10.

Pryor discloses a method of preparing heteroepitaxial diamond films on silicon substrates. In accordance with a method of Pryor, interface layers are first formed on suitable substrate. After the interface layers are formed, then heteroepitaxial diamond films are deposited on to the interface layers using CVD techniques. The CVD techniques of Pryor use reactive gas mixtures containing hydrogen, a carbon-containing gas or gases, and optionally, oxygen-containing gas or gases, which are introduced into a reaction chamber at low pressures.

Pryor clearly fails to teach or suggest any of the features recited in the independent Claims 1 and 10. Specifically, Pryor fails to teach or suggest the use of a liquid precursor without a gas stream, wherein the liquid precursor enters the metering valve as liquid and vaporizes upon entry into reaction chamber inlet at pressures in a range of 70 to 130 Torr, such as recited in the independent Claim 1, or upon entry into a reaction chamber at pressures in a range of 10 to 130 Torr, such as recited in the independent Claim 10.

Versteeg teaches a system that allows for delivering liquid precursor into a chemical vapor deposition reaction chamber. The solutions are injected through atomizing nozzles, which ensure that the liquid will be vaporized quicker in the reaction chamber. The liquid precursor can be injected in discrete, measured pulses through use of solenoid valves, or injected continuously.

However, Versteeg fails to teach or suggest a method for forming diamond that uses a liquid precursor, wherein the liquid precursor enters the metering valve as liquid and vaporizes during entry into a reaction chamber inlet or a reaction chamber. Nor does Versteeg teach or suggest that the liquid precursor is formed from a mixture of methanol and at least one carbon and oxygen containing compound that has carbon to oxygen ratio that is greater than one.

Robson discloses a method of introducing feed stock to the reaction chamber to form diamond. Robson teaches that suitable diamond-forming feedstock includes a mixture of alcohol and water. [Robson; Column 13, lines 18-21]

However, Robson clearly fails to teach or suggest the use of a liquid precursor that is substantially free of water and containing methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one. Nor does Robson teach or suggest flowing a liquid precursor into the reaction chamber using the metering valve, in the

absence of a gas stream, wherein the liquid precursor enters the metering valve as liquid and vaporizes during entry into the reaction chamber.

As mentioned above, Shinya simply discloses a precursor containing methanol or ethanol. No mention is made concerning the addition of the carbon and oxygen containing compound. Pryor lists off a number of combinations for the precursor solution, including a recommendation to include oxygen. However, all of Pryor's solutions contain hydrogen, the very reactive gas the present invention and Shinya's are designed to exclude from the process. The fact that Pryor includes hydrogen in all of his solutions while Shinya's purpose is to eliminate hydrogen shows there is no motivation to combine Shinya with Pryor for any purpose. As described in detail above, even if one were to combine Pryor and Shinya, the presence or absence of hydrogen, a central aspect on which both disagree, renders the combination impractical and unlikely.

In light of the arguments against combining Shinya and Pryor, it should also be noted that neither relates the significant benefits of using the present invention's precursor solution - which also proves that no evidence exists leading to a motivation to combine. In Paragraphs 0027-0033 of the present application, the Applicant discloses multiple benefits of using the solution. In Paragraph 0028, Lines 1-6, it is provided that "When the liquid precursor [is composed of the disclosed methanol-based solution], diamond growth is substantially uniform, reproducible, and at a higher growth rate than with conventional CVD methods." This is due to the unique deposition-aiding radicals that the methanol vapor releases when it disassociates. In Paragraph 0033 Lines 11-15, the Applicant notes that "...diamond crystallites could be grown on aluminum at temperatures below that of the melting point of aluminum...Also, diamond crystallites can be grown without seeding, which is difficult to do using other chemical vapor deposition systems."

With respect to the pressure ranges of 10 to 130 Torr and 70 to 130 Torr, these ranges are indeed novel and more importantly were not obvious prior to this invention due to the fact that they are enabled by the recommended liquid precursor, the liquid precursor being substantially free of water and containing methanol and at least one carbon and oxygen containing compound having a carbon-to-oxygen ratio greater than one. Since the disclosed liquid precursor is novel and non-obvious, then the pressure ranges it affords are also nonobvious, especially when considering the fact that the ranges are larger and wider than any of the other ranges disclosed in the cited references.

For all of the reasons stated above, the Applicant contends that each of the independent Claims 1 and 10 is allowable over the teachings of Shinya alone or in combination with Prior and either Versteeg or Robson.

Claims 2-9 all depend on the independent Claim 1 and Claims 11-14 and 18-25 all depend on the independent Claim 10. As described above, the independent Claims 1 and 10 are both allowable over the teachings of Shinya alone or in combination with Pryor and either Versteeg or Robson. Accordingly, Claims 2-9, 11-14 and 18-25 are also all allowable as being dependent on allowable base claims.

For the reasons given above, Applicants respectfully submit that Claims 1-14 and 18-25 are now in a condition for allowance, and allowance at an early date would be appreciated. Should the Examiner have any questions or comments, the Examiner is encouraged to call the undersigned at (408) 530-9700 to discuss the same so that any outstanding issues can be expeditiously resolved.

Respectfully submitted,
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